EVALUATION OF ARSENIC AS A CHEMICAL OF POTENTIAL CONCERN AT PROPOSED SCHOOL SITES IN THE LOS ANGELES AREA

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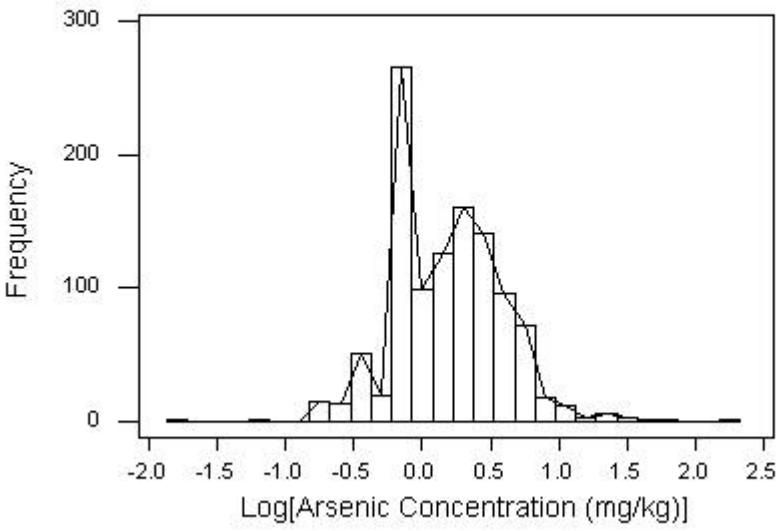
Abstract

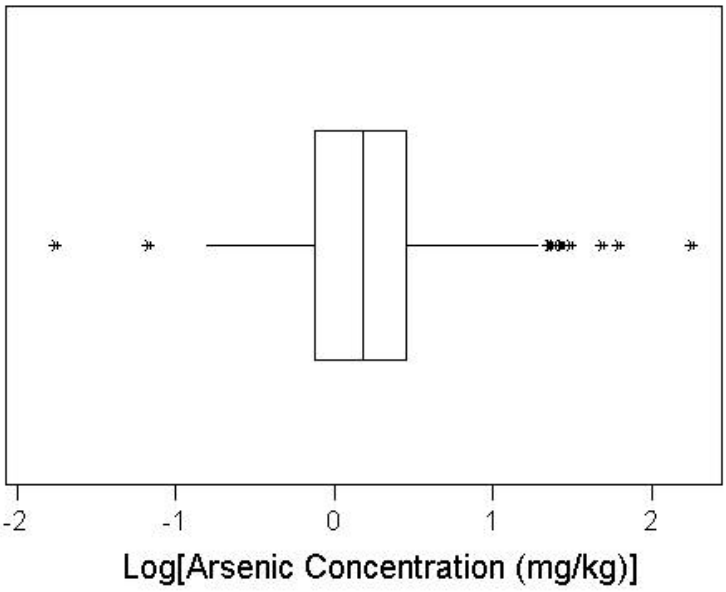
Metals are naturally occurring in soil, and as such, can prove problematic when identifying chemicals of potential concern (COPC) for risk assessment purposes. Arsenic is one of the more contentious metals because the concentration at which it poses an unacceptable risk is often well below background and ambient levels typically encountered. HERD used the combined arsenic data from 19 sites (1097 individual sample locations) to establish a regional, ambient arsenic range for the Los Angeles area. The upper limit of the arsenic ambient range, 11.3 mg/kg, was defined as the 95% Upper Confidence Limit of the 99th Percentile Concentration ($UL_{0.95}(X_{0.99})$). The following summarizes the combined arsenic data set and presents the statistical methodology used to derive this upper-bound, ambient arsenic concentration.

Data Evaluation

A total of 19 sites, distributed throughout the greater Los Angeles area , were included for this analysis. The number of samples from each site ranged from 4 to 363, and they were collected from depths ranging from surface (0 to 1 foot) to 10 feet. The vast majority of samples were collected between surface and 5 feet. The data from the 19 sites were combined into a single data set of 1097 samples. Individual sample concentration ranged from non-detect (0.75 mg/kg or less) to 177 mg/kg. Figure 1 presents a plot of the frequency verses arsenic concentration, also known as a histogram. The shape of the histogram clearly demonstrates a classical, lognormal distribution.

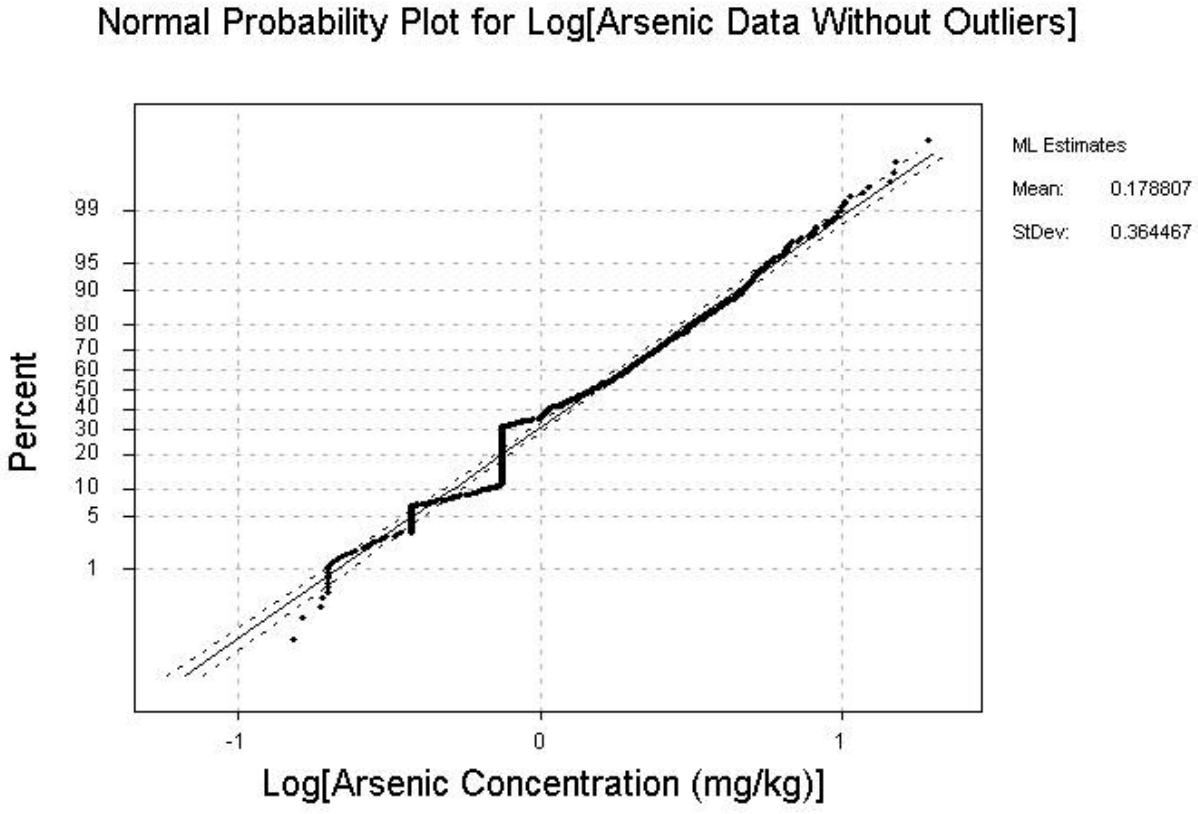


Because of the large sample size, wide range of arsenic concentrations and obvious extremes of the distribution, the data were analyzed for values that do not conform to the pattern established by the majority of values in the data set, e.g., ***outliers***. To determine the outliers in the arsenic data set, a pictorial summary called the box plot was utilized. The Box Plot (Figure 2) indicates that the nine largest and two lowest values are outliers (e.g., 177, 61.4, 49.2, 31.0, 27.6, 26.5, 24.0, 23.3, 22.7, 0.067 and 0.0173 mg/kg).



Statistical Methodology

The large number of data points well characterizes the extremes of the distribution, thereby making it possible to use an estimate of an upper percentile of ambient arsenic concentrations as the value to be compared with the onsite C_{max}. An upper 100(1 - α)% confidence limit for the true pth quantile, x_p, can be calculated if the underlying distribution is normal. As shown in Figure 5, the log-transformed arsenic data is normally distributed (i.e., the arsenic data fits a lognormal distribution).



For this analysis, the 95% Upper Confidence Limit on the 99th-Percentile was chosen as the upper limit concentration. The upper limit of the data set can be estimated according to the following equation:

$$UL_{1-\alpha}(x_p) = \bar{x} + sK_{1-\alpha,p}$$

Where,

$UL_{1-\alpha}(x_p) = The\ Upper\ Limit\ of\ the\ data\ set$

$\bar{x} = Mean\ \ of\ the\ data\ set$

$s = Std.\ Dev.\ of\ the\ mean$

$K_{1-\alpha,p} = Statistical\ tolerance\ factor\ \ for\ estimating\ an\ Upper\ 100(1-\alpha)$
$Confidence\ Limit\ on\ the\ pth\ Quantile$

For calculating the 95% confidence limit of the 99th quantile of the arsenic data set, excluding outliers, $\boldsymbol{K_{0.95,\ 0.99}}$ = **2.40** (from Table A3, Gilbert 1987). Using the mean and standard deviation of the arsenic data set, the $\boldsymbol{UL_{0.95}(X_{0.99})}$ was calculated as follows:

$$UL_{0.95}(X_{0.99}) = 0.1788 + (2.40)(0.3646)$$
$$= 1.054$$

Since the arsenic data is log-transformed, the Upper Limit Concentration is the antilogarithm of this value.

$$UL_{0.95}(X_{0.99}) = 10^{1.054}$$

= **11.32 mg/kg**

Conclusions

Based on the data analyzed, the 95% Upper Confidence Limit of the 99th percentile Concentration ($\boldsymbol{C_{UL0.95(X0.99)}}$) for arsenic in the LAUSD is 11.3 mg/kg. This concentration can be used to determine if the onsite $\boldsymbol{C_{MAX}}$ is less than or equal to $\boldsymbol{C_{UL0.95(X0.99)}}$. If all the onsite samples are less than the $\boldsymbol{C_{UL0.95(X0.99)}}$, then arsenic can be eliminated as a COPC at the site. If some onsite samples are greater than the $\boldsymbol{C_{UL0.95(X0.99)}}$, then these samples should be further evaluated in consultation with technical staff from the Department of Toxic Substances Control.